

invention may be advantageously employed in a single turbine engine powered aircraft as well.

Referring to FIG. 1, the aircraft is shown schematically at 10 and includes first and second turbine engines 12 and 14 respectively for propulsion purposes. Generally, the engines 12 and 14 will propel the aircraft 10 by means of thrust but the invention contemplates that they may be coupled to airfoils such as propellers or unducted fans for propulsion purposes as well.

Each of the engines 12 and 14 is coupled to a respective AMAD 16, 18 or airframe mounted accessory drive unit. As is well known, the AMADs 16 and 18 are gear boxes ultimately connected to a turbine driven shaft associated with the respective engines 12 and 14. Each AMAD 16, 18, mounts several accessories. For example, and as illustrated in FIG. 1, each AMAD 16, 18, mounts and drives a pair of hydraulic pumps 20, 22 as well as an integrated drive generating system 24 of known construction for providing electrical power to other aircraft systems. As illustrated in the drawing, an emergency starting and power generating system shown at 26 is associated with AMAD 16 while a conventional ATSM or air turbine starter motor 28 is associated with the AMAD 18.

Each of the engines 12, 14, has provision for the supply of bleed air on lines 30, 32 and provision is also made for possible hook-up to a ground based supply of compressed air 34 such as a ground cart or the like. Through suitable valving of a conventional nature, bleed air, which will be under compression, may be taken from either of the engines 12 and 14 and supplied to either the engine starting and emergency power generating system 26 or the ATSM 28 to start the other engine. Alternatively, compressed air may be taken from the ground source 34 for the same purpose.

Turning to FIG. 2, the engine starting and emergency power generating system 26 of the invention will be described in greater detail. The same includes a stored energy system, generally designated 36, which in turn includes a tank or storage vessel 38 for a combustible fuel such as JP4 fuel that may be also used to power the engines 12 and 14. Also included is a two-stage combustor 40 which may be in the form of a vessel that can (a) house the reaction whereby fuel from the tank 38 is oxidized and (b) the vaporization of additional fuel from the tank 38 as a result of exposure to the hot gases of combustion resulting from oxidation of the fuel. The resulting hot gases of combustion and vaporized fuel may exit the combustor 40 via a duct 42.

The two stage combustor 40 may be of the type disclosed in the commonly assigned application of Shekleton, Ser. No. 123,303, filed Nov. 20, 1987 and entitled Hot Gas Generator of the construction disclosed in the commonly assigned application of Shekleton, Brower and Vershure (attorneys docket no. B02902-AT6) forwarded Nov. 15, 1988, and entitled Staged, Co-Axial, Multi-Point Fuel Injection in a hot gas generator", the details of both of which are herein incorporated by reference.

The stored energy system 36 also includes a pressure vessel 44 for housing an oxidant for fuel contained in the tank 38. The oxidant may be compressed air, oxygen enriched air, or even pure oxygen. When the aircraft 10 is equipped with a so-called OBIGGS or on board inert gas generating system, the stream of oxygen enriched air that is usually dumped overboard may be passed from the OBIGGS along a line 46 to the vessel 44 for storage therein as more fully explained in my commonly

assigned co-pending application Ser. No. 133,492, filed Dec. 14, 1987, and entitled Dual Function Gas Generation System for an onboard installation on turbine powered aircraft, the details of which are herein incorporated by reference.

The vessel 44 includes an outlet line 48 which extends to a tubular heat exchanger 50 that surrounds the combustor 40 and which is in good heat transfer relation thereto. Oxidant leaving the vessel 44 thus serves to cool the combustor 40. After so doing, the same is combined with fuel at a junction 52 connected to an inlet 54 for the combustor 40. Thus, a mixture of fuel from the tank 38 and oxidant from the vessel 44 is introduced into the combustor 40 so that the fuel may be oxidized therein. Control of the fuel flow from the tank 38 is exercised by a controller 56 of known type. A certain amount of the fuel flowing toward the junction 52 from the controller 56 may be diverted along a line 58 to be injected into the combustor 40 at a relatively downstream location 60 just upstream of the outlet 42 so as to be vaporized by the hot gases of combustion resulting from the injection of oxidant and fuel at the inlet 54. Such vaporized fuel increases the volume of gas leaving the combustor 40 through the outlet 42 for purposes to be seen.

A radial inflow turbine wheel 62 includes an output shaft 64 which is journaled by bearings 66. An annular nozzle structure, generally designated 68, surrounds the radially outer periphery of the turbine wheel 62 and is a dual nozzle structure. Specifically, in side by side relation along the rotational axis 70 of the turbine wheel 62 there is a first nozzle 72 and a second nozzle 74. Both of the nozzles are intended to direct gas at the turbine wheel 62 to drive the same. More particularly, the nozzle 72 is in fluid communication with a plenum 76 into which compressed air may be introduced on a line 78. The line 78 is illustrated in FIG. 1 and it will be appreciated that compressed air from the bleed air line 32 of the engine 14 or from the ground source 34 may be directed to the line 78.

A second plenum 80 is connected to the second nozzle 74 and is in fluid communication with the outlet 42 of the combustor 40. Thus, hot gases of combustion from the combustor 40, along with such vaporized fuel as may be introduced at the point 60, may be directed via the second nozzle 74 against the turbine wheel 62 to drive the same.

The shaft 64 mounting the turbine wheel 62 mounts the sun gear 82 of a reduction planetary gear transmission, generally designated 84. The planetary gear transmission is connected via an output shaft 86 to a two-way clutch 90 which preferably is a dump and fill fluid coupling as schematically illustrated at 92 and which has a clutch input housing 93.

In any event, the two-way clutch 90 includes a first output shaft 94 within the AMAD 16 and in driving relation thereto. By means of this connection, rotational power conveyed to the shaft 94 through appropriate selective engagement of the clutch 90 can be employed to drive the engine 12 for start up purposes.

A second output 96 from the clutch input housing 93 extends directly to a gear train shown somewhat schematically at 98 and ultimately to a drive gear 100 for a power generator 102. The power generator 102 may be an electrical generator, a hydraulic pump, or both. Consequently, whenever the clutch input housing 93 is engaged it will provide power to the second output 96, and the power generator 102 will be driven.